Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(5): 1908-1912
Received: 16-07-2018
Accepted: 18-08-2018

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Study on the growth of *Schizothorax curvifrons* (Cyprinidae: cypriniformes) in river Jhelum Kashmir

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Abstract
Schizothorax curvifrons, an indigenous cyprinid fish of Kashmir, forms an important coldwater fishery resource of the valley. The present study was aimed to determine some growth parameters of *S. curvifons* inhabiting river Jhelum in Kashmir. Growth was obtained at monthly intervals and the regression of L_{t+1} on L_t was used for the estimation of Asymptotic length (L_∞) and growth coefficient (K). The estimated values of L_∞ and K by Modal Progression Analysis were found to be 493 mm and 0.091 month^{-1} respectively. The value of t_o was estimated by von Bertalanffy Growth Function at 0.007529 years.

Keywords: *Schizothorax curvifrons*, Jhelum, asymptotic length, growth coefficient, snow trout

Introduction
Typically, growth can be defined as the change in size (length, weight) over time. However, it can energetically, be defined as the change in calories stored as somatic and reproductive tissues. The latter definition is useful for understanding the factors that affect growth because of conversion of the ingested food energy into metabolic or growth or excreted energy (Brett and Groves, 1979). Although, most of the fish continue to grow throughout their lives, growth is not constant over the years. Consequently, growth has been one of the most intensively studied aspects of fish biology. It is a good indicator of the health of individuals and populations. The growth rate is an important parameter that influences population dynamics in fishes (Bal and Rao, 1984). It is variable because it greatly depends on a number of biotic factors such as age, maturity, ingested food quality and quantity and presence of the predators, stress, pollution, etc. It is also influenced by abiotic factors, such as temperature, photoperiod, dissolved oxygen and salinity. All these factors interact with each other to influence the growth rate. Growth parameters mainly involve asymptotic length (L_∞), asymptotic weight (W_∞) and growth coefficient (K). L_∞ and W_∞ are the maximum length and weight respectively to which a fish would grow on average if it lived to a very old age.

The sub family Schizothoracinae is a group of specialized fishes, dominant in the torrential mountain streams of the Himalyas and Central Asia. They are confined to cold regions and to localities possessing snow fed rivers and thus commonly called as snow trouts. Among the schizothoracids inhabiting Kashmir waters, the cyprinid, *Schizothorax curvifrons*, locally known as *Sattar Gad*, is an indigenous, omnivorous and cold-water teleost inhabiting rivers, lakes and swamps. This species can be recognized by an elongated and streamlined body, somewhat compressed with its depth 5.1 to 5.8 times in standard length. The maximum reported size of this fish is 56 cm in total length (Berg, 1964) and 1.3 kg in weight (Talwar and Jhingran, 1991). However, scarce information is available on the growth parameters of *S. curvifrons* from river Jhelum. In the present paper, an attempt has been made to investigate some growth parameters of *S. curvifrons* inhabiting river Jhelum.

Materials and methods
A total of 298 specimens of *S. curvifrons* were studied for a period of one year from May 2013 to April 2014. The samples were collected every month randomly from Chattabal landing center of Srinagar, Kashmir to determine the length frequency data of *S. curvifrons*. The length of individual fish was measured from the anterior most part of the body to the tip of the caudal fin to the nearest mm by using fish measuring board. The weight of the fish was recorded to the nearest gram on electronic digital weighing balance (Shimadzu). Total catch of the species on the day of observation was noted. The length frequency data was grouped into 20 mm class

interval, raised for the day and subsequently for the month using the method of Sekharan (1962). Growth was investigated by fitting the von Bertalanffy Growth Function (VBGF) to length frequency data (Bertalanffy, 1938). The mathematical form of the length and weight based von Bertalanffy's growth model as given by Nikolsky (1969) and Sparre and Venema (1998) was applied:

$$L_t = L_\infty [1\text{-exp.}^{-(K \times (t-t_0)}], \text{ and}$$
$$W_t = W_\infty [1\text{-exp.}^{-(K \times (t-t_0)}]^{b}$$

Where, L_∞ is the asymptotic length;
W_∞ is the asymptotic weight;

K is the growth coefficient or curvature parameter, and
t_o is the initial condition parameter or arbitrary origin of growth
In the present study various methods were used to arrive at a reasonably accurate estimate of growth parameters, employing scatter diagram technique where the progression of modes were analyzed using Devaraj (1983), the Ford-Walford Plot (Ford, 1933 and Walford, 1946) and von Bertalanffy Plot (1934).

Modal Progression Analysis by scatter diagram technique (Devaraj, 1983)
From length frequency data, the dominant modal values were determined for every month and these values were plotted on graph paper with the modal lengths (in mm) on the y-axis and the time (in months) on x-axis. The modes were then traced from month to month subjectively perceived to belong to the same cohorts, to determine the age as well as the rate of growth. Monthly mean lengths were used for regression of L_t against $L_{(t+1)}$; where, L_t is length for month and $L_{(t+1)}$ the length for subsequent month which is basically following the Ford (1933) and Walford (1946) Plot where by the:

L_∞ was estimated by using the relationship

$$L_\infty = \frac{a}{(1-b)}$$

and K was estimated by the relationship K = - 1n (b)

Ford-Walford Plot (Ford, 1933 and Walford, 1946)
The method introduced by Ford (1933) and Walford (1946) has gained wide application because the plot can be used to obtain a quick estimate of L_∞.
From the von Bertalanffy growth equation it follows a series of algebraic manipulations that:

$$L\,(t+\Delta t) = a + b*L\,(t)$$

Where, $a = L_m*(1 - b)$ and
$b = \exp(- K * \Delta t)$

Since L and L_∞ are constants, 'a' and also 'b' become constants if Δt is a constant. The growth parameters K and L_∞ are derived from:

$K = - 1/\Delta t* \ln b$ and
$L_\infty = a/1\text{-}b$.

Estimation of "t_o" by von Bertalanffy plot (1934)
For estimation of the third parameter of VBGF, the t_o, von Bertalanffy's (1934) equation was used. Historically, the first method for estimating the parameters of VBGF was that proposed by von Bertalanffy (1934), the method requires the use of a set value for the asymptotic size (L_∞, or W_∞)
Von Bertalanffy equation can be written:

$$-\ln[1-(L_t/L_\infty)] = -K * t_o + K * t$$
This has the form of linear regression y=a+bx
$$y = -\ln[1-(L_t/L_\infty)]$$
$$x = t$$

Which, give a set of length-at-age data, an estimate of L_∞ provides for intercept "a" and slope "b" which can be used to obtain K and t_o through the equations:

K = b
$t_o = -a/b$

Result
Growth parameters
In the scattergram technique (Devaraj, 1983) six almost identical curves were drawn (Table 1 and Fig. 1) at monthly intervals based on the progression of modes. The regression of L_{t+1} on L_t gave the values of 'a' and 'b' which were used for the calculation of 'L_∞' (asymptotic length) and 'K' (growth coefficient). The estimated value of 'L_∞' and 'K' by this method was found to be 493 mm and 0.091 $month^{-1}$ respectively. The monthly mean lengths obtained by the scattergram technique (Devaraj, 1983) were utilized in the Ford-Walford Plot (Ford, 1933 and Walford, 1946) for the estimation of L_∞ and K. Using this method, L_∞ and K were estimated at 495 mm and 1.627 $year^{-1}$ respectively. From the growth parameters estimated by the two methods, L_∞ and K values of 493 mm and 0.091 $month^{-1}$ respectively obtained by scattergram technique (Devaraj, 1983) appeared more reasonable and hence were considered for estimation of t_o.

Estimation of t_o by von Bertalanffy's plot (VBGF)
The estimated value of t_o are presented in table 10 and the calculated growth curve for *S. curvifrons* by applying VBGF equation is presented in the Fig. 2. The value of t_o was estimated at 0.007529 year by von Bertalanffy's Plot using monthly mean length and L_∞ obtained by scattergram technique (Table 2; Fig. 2 and 3).

Table-1: Progression of modal length (mm) in successive months for *S. curvifrons* as obtained from Scattergram technique

Months	Curves						Average (mm)
	A	B	C	D	E	F	
1	50	50	47	52	55	52	51
2	95	100	90	90	105	97	96
3	140	140	130	130	149	130	136
4	180	190	170	170	190	170	176
5	220	225	210	201	227	205	213
6	255	259	235	230	247	245	249
7	270	260	240	235	255	250	250
8	300	300	250	244	270	265	269
9	310	320		262	307		293
10	312	325			308		312
11	337	355					346
12	360	400					380
13	372	405					389
14	412	407					410
15	412	407					420
16	448						448

a = 44.33	b = 0.91	$L_\infty = a/(1-b) = 493$ mm	K = -ln b = 0.09 month^{-1}	$R^2 = 0.99$

Table-2: Estimation of t_o by von Bertalanffy's plot for *S. curvifrons*

S. No.	t (Age)/year (X)	Lt	L_∞ - Lt	L_∞- Lt/L_∞	–ln (L_∞ - Lt/L_∞) (Y)
1	*0.083*	*51*	*442*	*0.897*	*0.109*
2	*0.167*	*96*	*397*	*0.805*	*0.217*
3	*0.250*	*136*	*357*	*0.724*	*0.323*
4	*0.333*	*176*	*317*	*0.643*	*0.442*
5	*0.417*	*213*	*280*	*0.568*	*0.566*
6	*0.500*	*249*	*244*	*0.495*	*0.703*
7	*0.583*	*250*	*243*	*0.493*	*0.707*
8	*0.667*	*269*	*224*	*0.454*	*0.789*
9	*0.750*	*293*	*200*	*0.406*	*0.902*
10	*0.833*	*312*	*181*	*0.367*	*1.002*
11	*0.917*	*346*	*147*	*0.298*	*1.210*
12	*1.000*	*380*	*113*	*0.229*	*1.473*
13	*1.083*	*389*	*104*	*0.211*	*1.556*
14	*1.167*	*410*	*83*	*0.168*	*1.782*
15	*1.250*	*420*	*73*	*0.148*	*1.910*
16	*1.333*	*448*	*45*	*0.091*	*2.394*

a = -0.147	b = 1.627	$t_o = (-a/b)/12 = 0.007529$	$R^2 = 0.954$

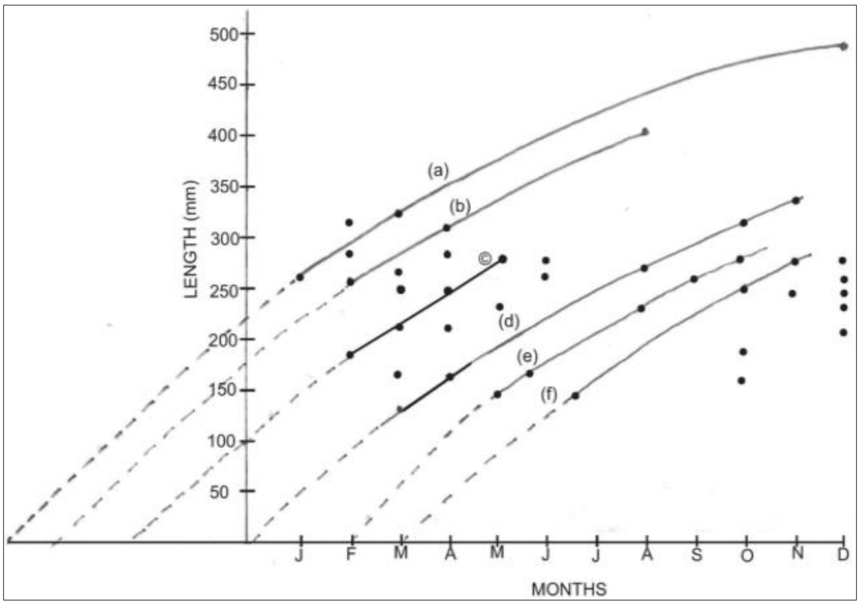

Fig. 1: Modal progression analysis (Scattergram technique) of *S. curvifrons* in different months

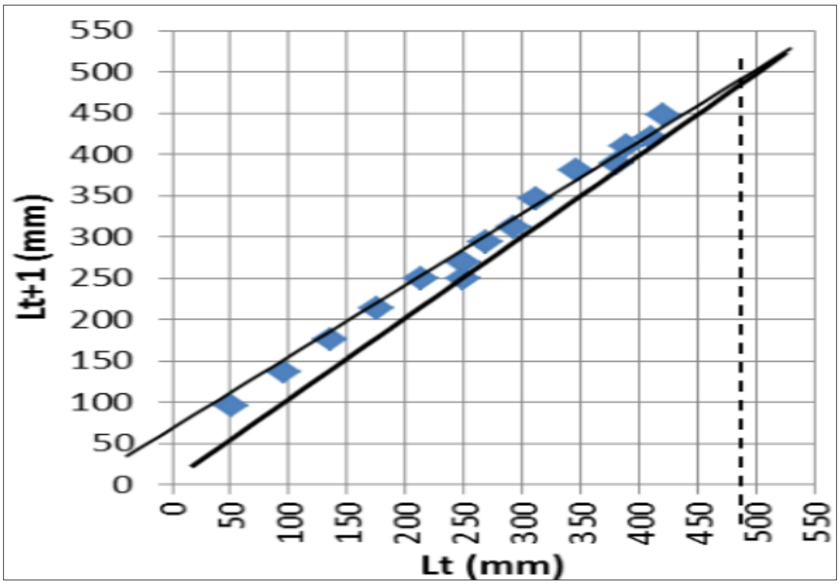

Fig 2: Ford-Walford plot for estimation of L_∞ and K for *S. curvifrons*

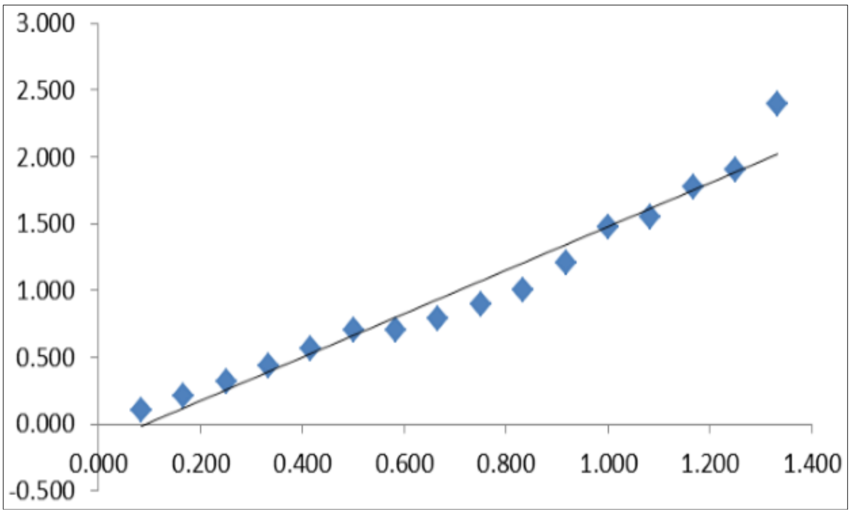

Fig 3: von Bertalanffy's Plot for estimation of t_o for *S. curvifrons*

Discussion

In the present study, Modal Progression Analysis by scatter diagram technique (Devaraj, 1983) and the Ford-Walford plot (Ford, 1933 and Walford, 1946) were used for the estimation of growth parameters. However, the values of asymptotic length (L_∞) of 493 mm and growth coefficient (K) of 0.091 month^{-1} obtained from the scattergram technique (Devaraj, 1983) were considered reasonable and used as input parameters for estimation of t_o by the von Bertalanffy's Plot (Bertalanffy, 1934). The value of t_o was estimated at 0.007529 year. Reports on the growth parameters of Schizothoracids in Kashmir are negligible. Bhat *et al.* (2013) reported the values of 472 mm and 0.0783 month^{-1} for L_∞ and K respectively in *S. curvifrons*. Sabah and Khan (2014) while studying the growth and age estimation of *Schizothorax curvifrons* in Kashmir valley reported the von Bertalanffy growth equation as L_t = 49.8 (1-e-0.263(t+0.34)) for *S. curvifrons.*

Growth is an important factor that determines the fish population dynamics (Zhan, 1995 and Ricker, 1975) and directly contributes to stock increases. For a given fish species, reliable estimation of growth parameters is a key issue in developing sustainable fisheries stock assessment and management (King, 1995; Walters, 1998 and Chen & Paloheimo, 1998). The growth parameters viz Length infinity or Asymptotic length (L_∞) and Growth Coefficient or Curvature parameter (K) of VBGF model are important in fisheries science. The K parameter is closely related to metabolic rate of fish. A high value of K indicates a high metabolic rate and such fishes mature at early age (T_m) or at size (L_m) which is large in relation to their asymptotic length L_∞ (Qasim, 1973).The growth of a fish is not uniform throughout a year or throughout its lifetime and shows alternating fast and slow growth rate depending on favourable or adverse ecological conditions (Singh and Sharma, 1995).

Conclusion

The present study estimates some parameters of growth of *S. curvifrons* from river Jhelum namely, asymptotic length and growth coefficient which can be used in proper management of this commercially important resource of the valley.

References

1. Bal DV, Rao KV. Oil sardine. Marine fisheries of India, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1984, 470.
2. Berg LS. Freshwater fishes of the USSR and adjacent countries. Vol 2, 4th edition. Israel Program for scientific Translations Ltd., Jerusalem, 1964.
3. Bhat FA, Balkhi MH, Najar AM, Shah FA, Khan I. Conservation of schizothoracid (*Schizothorax esocius* Heckel) in aquatic environments of Kashmir. Himalayas *vis a vis* study on its various biological parameters. In**:** National conference on Status and Conservation of Biodiversity in India with special reference to Himalaya, October. 4-5, 2013.
4. Brett JR, Groves TDD. Physiological Energitics. In: Fish Physiology. 8:1979, 279-352.
5. Chen Y, Paloheimo JE. Can a more realistic model error structure improve parameter estimation in modelling the dynamics of fish populations. Fishereis Research. 1998, 38:9-19.
6. Devaraj M. Fish population dynamics: A course manual, CIFE Bull. 1983; 3(10):83-89.
7. Ford E. An account of herring investigation conducted by Plymouth during the years from 1924-1933. J. Mar. Biol. Ass. U.K, 1933, 19:305-384.
8. King M. Fisheries Biology, Assessment and Management. Fishing News Books, Oxford, 1995.
9. Nikolsky, GW. Fish Population Dynamics. Oliver and Boyd. Edinburg, 1969, 323.
10. Qasim SZ. An appraisal of the studies on maturation and spawning in marine teleosts from the Indian waters, Indian Journal of Fisheries. 1973; 20(1&2):166-181.
11. Ricker WE. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 1975; 191:1-382.
12. Sabah Khan, MA. Precise age estimation and growth of three Schizothoracinae fishes from Kashmir valley. Zoology and Ecology. 2014; 24(1):16-25.
13. Sekharan KV. On oil sardine fishery of Calicut during the years 1955-1956 to 1958-1959. Indian. J Fish. 1962; 9A (2):679-700.
14. Singh D, Sharma RC. Age and growth of a Himalayan teleost *Schizothorax richardsonii* (Gray) from Garhwal Hills (India), Fisheries Research. 1995; 24:321-329.
15. Sparre P. Venema, SC. Introduction to tropical fish stock assessment. Part 1. Manual. FAO Fisheries Technical Paper 306. Rome, 1998, 407.
16. Talwar, PK Jhingran, AG. 1991. Inland Fishes of India and Adjacent Countries. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, Bombay, Calcutta. 1991; 1:402.

17. Bertalanffy L. von. Vntersuchungen uber die Gesetzlichkeiten des Wachstums I. Allgemeine Grundiagen der Theorie, mathematische und physiologische Gesetzlichkeiten des Wachstum bei Wassertieren Roux Arch. Entwicklungs mech. 1934; 131:613-652.
18. Bertalanffy L. von. A quantitative theory of organic growth (Inquiries on growth laws 2). Human Biology. 1938; 10:181-213.
19. Walford LA. A new graphic method of describing growth of animals. Biol. Bull. 1946; 90(2):141-147.
20. Walters CJ. Evaluation of quota management policies for developing fisheries. Can. J Fish. Aquat. Sci. 1998; 55:2691-2705.
21. Zhan, BY. Fish Stock Assessment. Agriculture Press of China, Beijing, 1995, 18-57.